UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

Note to Reader
January 15, 1998

Background: As part of its effort to involve the public in the implementation of the Food Quality Protection Act of 1996 (FQPA), which is designed to ensure that the United States continues to have the safest and most abundant food supply. EPA is undertaking an effort to open public dockets on the organophosphate pesticides. These dockets will make available to all interested parties documents that were developed as part of the U.S. Environmental Protection Agency's process for making reregistration eligibility decisions and tolerance reassessments consistent with FQPA. The dockets include preliminary health assessments and, where available, ecological risk assessments conducted by EPA, rebuttals or corrections to the risk assessments submitted by chemical registrants, and the Agency's response to the registrants' submissions.

The analyses contained in this docket are preliminary in nature and represent the information available to EPA at the time they were prepared. Additional information may have been submitted to EPA which has not yet been incorporated into these analyses, and registrants or others may be developing relevant information. It's common and appropriate that new information and analyses will be used to revise and refine the evaluations contained in these dockets to make them more comprehensive and realistic. The Agency cautions against premature conclusions based on these preliminary assessments and against any use of information contained in these documents out of their full context. Throughout this process, If unacceptable risks are identified, EPA will act to reduce or eliminate the risks.

There is a 60 day comment period in which the public and all interested parties are invited to submit comments on the information in this docket. Comments should directly relate to this organophosphate and to the information and issues available in the information docket. Once the comment period closes, EPA will review all comments and revise the risk assessments, as necessary.

These preliminary risk assessments represent an early stage in the process by which EPA is evaluating the regulatory requirements applicable to existing pesticides. Through this opportunity for notice and comment, the Agency hopes to advance the openness and scientific soundness underpinning its decisions. This process is designed to assure that America continues to enjoy the safest and most abundant food supply. Through implementation of EPA's tolerance reassessment program under the Food Quality Protection Act, the food supply will become even safer. Leading health experts recommend that all people eat a wide variety of foods, including at least five servings of fruits and vegetables a day.

Note: This sheet is provided to help the reader understand how refined and developed the pesticide file is as of the date prepared, what if any changes have occurred recently, and what new information, if any, is expected to be included in the analysis before decisions are made. **It is not meant to be a summary of all current information regarding the chemical.** Rather, the sheet provides some context to better understand the substantive material in the docket (RED chapters, registrant rebuttals, Agency responses to rebuttals, etc.) for this pesticide.

Further, in some cases, differences may be noted between the RED chapters and the Agency's comprehensive reports on the hazard identification information and safety factors for all organophosphates. In these cases, information in the comprehensive reports is the most current and will, barring the submission of more data that the Agency finds useful, be used in the risk assessments.

Jack E. Housenger, Acting Director
Special Review and Reregistration Division

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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OFFICE OF
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TOXIC SUBSTANCES

11/2/98

MEMORANDUM

SUBJECT: **Tetrachlorvinphos**. (Chemical ID No. 083701/List A Reregistration Case No. 0321). Addendum to the HED Human Health Risk Assessment and RED Chapter dated 4/1/98. DP Barcode No. D249577.

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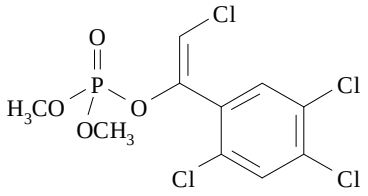
A comprehensive human health risk assessment was completed for the organophosphate (OP) active ingredient tetrachlorvinphos [(Z)-2-chloro-1-(2,4,5-trichlorophenyl)vinyl dimethyl phosphate] (K. Boyle RED Chapter dated 4/1/98), which superseded a risk assessment completed in 1995. The 4/98 risk assessment incorporated revisions required by the Food Quality Protection Act (FQPA) of 1996. In the 4/98 version of the RED, chronic (non-cancer) and carcinogenic dietary risk assessments were conducted, using recommended time-limited tolerances and anticipated residues. In addition, carcinogenic risk assessments were conducted for occupational and residential exposures. In the 4/98 RED Chapter, risk assessments for acute dietary and short- and intermediate-term residential and occupational exposures were deemed unnecessary, since Agency toxicologists had not identified toxic effects attributable to a single dose in studies conducted in laboratory animals.



tetrachlorvinphos

In May and June of 1998, meetings were conducted to assess consistency in selecting endpoints

and safety factors for all organophosphate pesticides. During these meetings, the HED Hazard Identification Assessment Review Committee (HIARC) selected endpoints for acute dietary and short- and intermediate-term risk assessments for tetrachlorvinphos. The FQPA Safety Factor Committee supported the conclusion that the additional safety factor required under FQPA could be removed for tetrachlorvinphos (refer to the summary documents, "Hazard Assessment of the Organophosphates: Report of the HIARC" and "FQPA Safety Factor Recommendations for the Organophosphates," B. Tarplee and J. Rowland, 7/7/98 and 8/6/98, respectively).

Based on the selection of acute dietary and short- and intermediate-term endpoints, revised dietary risk analyses were completed using more recent consumption data (C. Swartz memo dated 9/28/98), and short- and intermediate-term occupational and residential exposures and risks have been estimated (S. Hanley memo dated 11/3/98).

Use patterns supported through reregistration include oral larvicide uses for livestock, direct treatment of beef and dairy cattle (including lactating cattle), horses, poultry and swine; and livestock premise treatments. Homeowner use products allow application to pets and their bedding to control fleas and ticks. Based on these use patterns, dietary exposure through drinking water is not expected to occur. Therefore, residential exposure and dietary exposure through food are the only components of the aggregate exposure and risk assessment for tetrachlorvinphos.

SUMMARY/CONCLUSIONS

Available data indicate that estimated risks associated with chronic (both cancer and non-cancer) and acute dietary exposures are below the Agency's level of concern. Chronic and carcinogenic dietary risk estimates were refined using BEAD data which estimated the percentage of animals treated for direct dermal treatments and livestock feed-through uses. Acute dietary risk estimates were based on the recommended time-limited tolerances which were estimated using metabolism data, and are considered to be worst-case.

HED is most concerned with risks estimated for post-application residential exposures. The Agency's level of concern is exceeded for both carcinogenic (adults only) and short-term risk associated with contact with treated pets, including dermal contact (adults and toddlers) and hand-to-mouth activity (toddlers). Estimates of carcinogenic risk for tetrachlorvinphos are considered to be very conservative, based on assumptions made regarding the number of applications in a year, the amount/rate applied, and the number of years of pet ownership. No chemical-specific data were used in assessing residential exposures, but the conservative nature of the use assumptions is supported by the results of the National Home and Garden Pesticide Use Survey completed by the Agency in 1992.

A summary of incident reports associated with tetrachlorvinphos usage was presented in the J. Blondell and M. Spann memo dated 7/8/98; relatively few incidents have been reported, and there were no regulatory recommendations on the basis of these few incidents.

The 4/98 risk assessment addressed aggregate exposures/risk for tetrachlorvinphos. Since residential short-term exposure/risk and carcinogenic risk exceed the Agency's level of concern, revised aggregate risk assessments will be completed following refinement of residential exposure assessments. HED reiterates that based on the supported use patterns, there is no dietary exposure to tetrachlorvinphos through consumption of drinking water.

DATA REQUIREMENTS

Residue Chemistry

The residue chemistry data base is considered to be incomplete, largely due to the HED Metabolism Assessment Review Committee (MARC) decision to include 4 tetrachlorvinphos metabolites in the tolerance expression listed under 40 CFR §180.252. In most studies submitted to date, residues of the parent, tetrachlorvinphos were measured. The required residue chemistry data are essential to determine revised tolerance levels in livestock commodities:

OPPTS GLN No. 860.1340: Analytical methods capable of determining tetrachlorvinphos and metabolite residues in meat and milk are required.

OPPTS GLN No. 860.1380: Storage stability data are required for tetrachlorvinphos and its four metabolites in livestock tissues and milk.

OPPTS GLN No. 860.1480: Livestock feeding studies are required for poultry, swine and cattle.

Occupational and Residential Exposure

Additional data are required to assess dermal and inhalation exposures in indoor residential sites (OPPTS Series 875 Group B Guidelines).

DETAILED CONSIDERATIONS

TOXICOLOGY

Previous versions of HED risk assessments and supporting documents refer to the NOEL (no observed effect level) and LOEL (lowest observed effect level) in toxicology studies. In order to harmonize with other offices in EPA, and to express greater clarity in scientific decision-making, OPP/HED has decided to use the terms no-observed-*adverse*-effect-level (NOAEL) and lowest-observed-*adverse*-effect-level (LOAEL) [policy memorandum, M. Stasikowski, 9/22/98]. The new policy is reflected in the current assessment.

Details of toxicology studies submitted for tetrachlorvinphos are presented in the 4/98 version of the HED RED. Tetrachlorvinphos has relatively low acute toxicity in rats via oral and inhalation

routes, and low acute toxicity via the dermal route in rabbits; based on studies conducted in guinea pigs, it is considered to be a sensitizer. In subchronic and chronic toxicity studies conducted in rats and dogs, red blood cell (RBC) and plasma cholinesterase inhibition (ChEI) were observed at doses ranging from 43.2 to 1000 mg/kg/day. Systemic effects observed in these studies included reduced body weights and body weight gains, liver effects including increased liver weights, thyroid effects, and increased kidney weights. Clinical signs of neurotoxicity were not observed in the subchronic and chronic studies.

Developmental and reproductive toxicity studies conducted in rats and rabbits indicate no increased sensitivity of developing young relative to maternal animals due to either pre- or post-natal exposure to tetrachlorvinphos. In acute and subchronic neurotoxicity studies conducted in rats, transient clinical signs characteristic of cholinesterase inhibition were observed, but ChEI was not measured; LOAELs and NOAELs in these studies were either similar to or higher than those in the chronic and subchronic toxicity studies.

In an acute delayed neurotoxicity study conducted in hens, no clinical signs of neurotoxicity or neuropathology were observed; however, inhibition of neurotoxic esterase (NTE) was not assessed. Based on the results of the neurotoxicity studies, and on weight-of-the-evidence consideration of the database, the HIARC concluded a developmental neurotoxicity study is not required for tetrachlorvinphos.

Tetrachlorvinphos is considered to be a possible human (Group C) carcinogen based on statistically significant increases in combined hepatocellular adenoma/carcinomas in mice, and suggestive evidence of thyroid c-cell adenomas and adrenal pheochromocytomas in rats. A cancer potency factor (Q_1^*) of 1.83×10^{-3} $(mg/kg/day)^{-1}$ was estimated using the time-to-tumor model.

Endpoint Selection

Selection of endpoints for tetrachlorvinphos risk assessments was discussed in detail in the 4/98 HED RED Chapter. When endpoint selections for all organophosphates were evaluated for consistency, the HIARC determined that acute dietary and short- and intermediate-term occupational and residential exposure assessments should be conducted for tetrachlorvinphos. A summary of endpoints for risk assessment is presented in Table 1.

The acute dietary endpoint was selected from an oral subchronic toxicity study conducted in rats, in which plasma and RBC cholinesterase inhibition were observed at the LOAEL of 43.2 mg/kg/day; the NOAEL of 4.32 mg/kg/day is used for acute dietary risk assessment. Although ChEI was measured only at the conclusion of the study (13 weeks), the Committee assumed that the effects could have occurred after a single dose (as demonstrated for other OPs); although clinical signs of neurotoxicity were observed in the acute neurotoxicity study, the study did not assess ChEI. Consequently, the ChEI endpoint was selected from the subchronic study.

The Committee recommended using the endpoint and NOAEL selected from the subchronic toxicity study (ChEI, 4.32 mg/kg/day) for short- and intermediate-term occupational and residential exposure assessments. The Committee had previously selected a dermal absorption factor of 9.57% for dermal exposures, and a 100% absorption factor for inhalation exposures. Although the oral RfD established based on a chronic study in rats was selected for long-term occupational and residential exposure assessments, long-term or chronic exposures are not expected, based on supported use patterns.

Since all the endpoints were selected from animal studies, the conventional safety factors of 10X for intra-species variability and 10X for inter-species extrapolation were applied to determine acceptable margins of exposure (MOEs).

Table 1. Toxicological Endpoints for Risk Assessment.[1]

EXPOSURE SCENARIO	NOAEL (mg/kg/day)	ENDPOINT (LOAEL, mg/kg/day)	STUDY	UNCERTAINTY FACTORS[2]
Acute dietary aRfD = 0.04 mg/kg/day	4.23	Plasma/RBC ChE Inhibition at 13 weeks (43.2)	Subchronic Rat	100X (Conventional)
Chronic dietary (non-cancer) RfD = 0.04 mg/kg/day	4.23	Liver histological changes; adrenal changes (43.2)	Chronic Rat	100X (Conventional)
Cancer, $Q_1^* = 1.83 \times 10^{-3}$	NA	Based on adenomas/carcinomas and pheochromocytomas	Mouse carcinogenicity	NA
Short-/Intermediate-Term dermal	4.23	Plasma/RBC ChE Inhibition at 13 weeks (43.2) Use Dermal Absorption Factor of 9.57%	Subchronic Rat	100X (Conventional)
Short-/Intermediate-Term inhalation	4.23	Plasma/RBC ChE Inhibition at 13 weeks (43.2) Use Inhalation Absorption Factor of 100%	Subchronic Rat	100X (Conventional)

[1] NOAEL = No Observed Adverse Effect Level; LOAEL = Lowest Observed Adverse Effect Level; ChE = Cholinesterase; RBC = red blood cell (erythrocyte)

[2] Conventional UF of 100 includes 10X for inter-species extrapolation and 10X for intra-species variability.

DIETARY EXPOSURE/RISK

HED has recommended revocation of tolerances established in conjunction with application to plants, for which all registrations were voluntarily canceled in 1987. The existing tolerances recommended for revocation are for residues of tetrachlorvinphos *per se* in alfalfa; apples; cherries; field, pop and sweet corn fodder and forage; fresh and sweet corn; corn grain; cranberries; peaches; pears; and tomatoes.

Based on livestock metabolism data, the tolerance expression for tetrachlorvinphos [40 CFR §180.252] should be amended to include tetrachlorvinphos *per se* and its metabolites des-O-methyl tetrachlorvinphos, 1-(2,4,5-trichlorophenyl)ethanol (free and conjugated forms), 2,4,5-trichloroacetophenone, and 1-(2,4,5-trichlorophenyl)ethanediol. Time-limited tolerances for residues in livestock commodities must be maintained, based on feed-through and direct dermal uses on livestock; the recommended time-limited tolerances are based on livestock metabolism data, and exceed existing tolerances for residues in some commodities. Permanent tolerances will be established when adequate magnitude of the residue data for ruminants, swine and poultry are submitted.

In conducting dietary exposure assessments, HED uses consumption data from USDA's Continuing Surveys of Food Intake by Individuals, 1989-1992. The consumption data are coupled with residues in commodities to determine dietary exposure using DEEM™ Software, purchased under contract from Novigen Sciences, Inc.

For chronic dietary risk assessments, the DEEM™ Software estimates total dietary exposure to pesticides in foods based on mean consumption data. For acute dietary risk assessments, DEEM™ estimates short term (daily) total dietary exposure from individual consumption data. For both acute and chronic dietary exposures, DEEM™ calculates risk by comparing dietary exposure to the endpoints for risk assessment identified by the HIARC.

Acute and chronic (cancer and non-cancer) dietary exposure analyses conducted for tetrachlorvinphos incorporated DEEM™ default concentration factors. Since percent livestock treated data were incorporated into the anticipated residues for livestock commodities, no percent crop treated adjustments were made in the DEEM™ analysis. In chronic exposure assessments, the calculated exposure was compared to both the chronic reference dose (RfD) of 0.04 mg/kg/day and the Q_1* of 1.83×10^{-3} $(mg/kg/day)^{-1}$. In the acute assessment, the calculated exposure was compared to the acute reference dose (aRfD) of 0.04 mg/kg/day.

Using the recommended time-limited tolerances, estimated carginogenic dietary risk for the US Population was 5.0×10^{-6}. Refinement of the exposure analysis with the percent livestock treated data resulted in an estimated carcinogenic dietary risk of 2.2×10^{-7}, which is below the Agency's level of concern for carcinogenic risk.

Acute and chronic (non-cancer) dietary risk are considerably less than 100% of the acute reference dose (aRfD) and the chronic reference dose (RfD), and are therefore considered to be below the Agency's level of concern for acute and chronic (non-cancer) dietary risk. Refer to Tables 2 and 3 for details.

Table 2. Chronic Non-Cancer Dietary Risk, Expressed as a Percentage of the RfD.

Population Subgroup	% of RfD, based on	
	Recommended Tolerances	Anticipated Residues
U.S. Pop - 48 states - all seasons	6	<1
All infants (<1 year)	4	<1
Nursing infants (<1 year)	2	<1
Non-nursing infants (<1 year)	5	<1
Children (1-6 years)	14	<1
Children (7-12 years)	9	<1
Females (13-19 yrs/not preg. or nursing)	6	<1
Males (13-19 years)	7	<1

Table 3. Acute Dietary Exposure/Acute Dietary Risk Expressed as a Percentage of the Acute Dietary RfD.

Population Subgroup	Published Tolerances [99.9th Percentile]		Recommended Tolerances [99.9th Percentile]	
	Exposure (mg/kg/day)	% aRfD	Exposure (mg/kg/day)	% aRfD
U.S. pop - all seasons	0.360725	853	0.023278	55
All infants (<1 yr)	0.618855	1463	0.025864	61
Nursing infants (<1yr)	0.584849	1383	0.013685	32
Non-nursing infants (<1 yr)	0.573858	1357	0.025541	60
Children (1-6 yrs)	0.527648	1247	0.034018	80
Children (7-12 yrs)	0.314254	743	0.024028	57
Females (13-19 yrs)	0.227830	539	0.016028	38
Males (13-19 yrs)	0.197076	466	0.016088	38

OCCUPATIONAL AND RESIDENTIAL EXPOSURE/RISK

Tetrachlorvinphos is marketed in a variety of end-use products that include dusts, emulsifiable concentrates, wettable powders, treated articles, granulars for livestock feed-through purposes, and ready-to-use products (i.e., pressurized sprays and liquids). Tetrachlorvinphos concentrations in various formulations are: dusts (1 to 3 percent), emulsifiable concentrates (2.8 to 24 percent), wettable powders (50 to 75 percent), treated articles (approximately 15 percent), granulars for livestock feed-through purposes (<10 to approximately 98 percent), and ready-to-use products (1 to 2 percent).

Products containing tetrachlorvinphos are intended for use by individuals in the normal course of employment (i.e., they can be occupationally exposed), and can also be purchased and used by homeowners. Some occupational uses can lead to general population exposures in a residential setting (e.g., veterinary uses on domestic pets). Exposures are typically addressed for those who are involved in the application of pesticides (i.e., handlers or applicators) and those who are exposed to pesticides but who have not directly used them (i.e., post-application exposures). Handlers include professional applicators and homeowners. Post-application exposures include agricultural harvesters or children playing with a treated animal. The Agency anticipates that handler exposures occur in occupational settings, and that both handler and post-application exposure pathways exist for tetrachlorvinphos in residential settings. Handler exposure scenarios are limited to direct animal, premise and feed-through treatments. These scenarios generally indicate that handlers make applications using: ready-to-use packaging, handheld spray

equipment, and specialized equipment (e.g., for animal dipping and feed-through applications).

All occupational tetrachlorvinphos exposures were considered to be either short- or intermediate-term in nature; only short-term exposures were considered in residential settings. No chronic exposure scenarios are thought to exist for tetrachlorvinphos. Therefore, short- and intermediate-term exposure/risk assessments were conducted; in addition, a cancer assessment was completed using the Q_1* value estimated by the CPRC and lifetime average daily dose levels (LADDs).

Occupational Exposures/Risks

Handler Exposure/Risk

Handler assessments were completed for mixer/loaders preparing spray solutions using liquid and wettable powder formulations for applications using handheld equipment and for loading granulars into metering systems for feed-through purposes. Applicator (and combined mixer/loader/applicator) exposures were assessed for commonplace handheld equipment types including backpack, high pressure handwand, and low pressure handwand sprayers. Applicator exposures were also considered for animal dusting and aerosol can treatments (e.g., livestock and pets).

Occupational handler exposure/risk assessments often indicate a need for risk mitigation in order to ensure that label statements developed as a result of the risk assessment process are adequately protective. Three basic risk mitigation approaches are considered appropriate for controlling occupational exposures. These include administrative controls, the use of personal protective equipment (PPE), and the use of engineering controls. Occupational handler exposure assessments are completed using a baseline exposure scenario and, if required, increasing levels of risk mitigation (PPE and engineering controls) to achieve an appropriate margin of exposure (MOE) or cancer risk. The baseline clothing/PPE ensemble for occupational exposure scenarios generally consists of an individual wearing long pants, a long-sleeved shirt, no chemical-resistant gloves (except where noted), and no respirator. The first level of mitigation generally applied is PPE; for tetrachlorvinphos, PPE involves the use of an additional layer of clothing, chemical-resistant gloves, and a respirator.

The next level of mitigation considered in the risk assessment process is the use of engineering controls which, by design, attempt to eliminate the possibility of human exposure. Examples of commonly used engineering controls include closed tractor cabs, closed mixing/loading/transfer systems, and water-soluble packets. The use of a tiered mitigation approach was used in the completion of the handler exposure/risk assessment for tetrachlorvinphos.

One chemical-specific handler exposure study was submitted in support of the reregistration of tetrachlorvinphos [MRID 42622301, supporting data in MRIDs 44202701 and 44202702]. Separate mixer/loader (16 replicates) and applicator exposures (16 replicates) were quantified during application of a WP formulation in poultry houses using passive dosimetry techniques.

Test subjects wore a single layer of clothing and chemical resistant gloves, and applied the formulated product using a high volume/high pressure handwand device. The study was considered to be adequate for regulatory purposes.

Most exposure scenarios were addressed using the data from the *Pesticide Handlers Exposure Database (PHED V1.1)*. PHED was designed by a task force consisting of representatives from the U.S. EPA, Health Canada, the California Department of Pesticide Regulation, and member companies of the American Crop Protection Association. PHED is a generic database containing voluntarily submitted empirical exposure data for workers involved in the handling or application of pesticides in the field, and currently contains data for over 2000 monitored exposure events. The underlying assumption supporting use of PHED data is that exposure to pesticide handlers can be calculated generically (based on the available empirical data), since exposure is primarily a function of the physical parameters of handling and application process (e.g., packaging type, formulation type, application method, and clothing scenario).

To ensure consistency in the risk assessment process, a surrogate exposure table that contains a series of standard unit exposure values for various occupational exposure scenarios has been developed using PHED (*PHED Surrogate Exposure Guide of May, 1997*). This guide serves as the basis for the tetrachlorvinphos exposure assessment. The standard exposure values (i.e., the unit exposure values included in the exposure and risk assessment tables) are based on the "best fit" values calculated by PHED. The model calculates "best fit" exposure values by assessing data distributions and then calculates a composite exposure value representing the entire body, ranging from the geometric mean to the median of the selected data set. Exposure values calculated using PHED are of varying quality. Data quality is assessed by considering the analytical (e.g., recovery) and the design qualities of the data (e.g., number of available data points compared to guideline requirements) selected for the assessment. Each value used in the tetrachlorvinphos assessment has a distinct quality associated with it that affects characterization of exposures/risks.

Equipment type and the nature of mixing/loading operations generally define exposure scenarios included in pesticide handler exposure/risk assessments. These scenarios are further refined by application rate ranges and differences in cultural practice (e.g., acres or gallons applied per day vary based on crop). Nine occupational handler scenarios were identified for tetrachlorvinphos; associated exposures and risks were calculated for handlers at all levels of risk mitigation. Mitigation was applied to specific scenarios as required until an acceptable level of risk was attained or until the options for risk mitigation were exhausted.

Exposures for all but one of the nine handler scenarios were less than 0.5 mg/kg/day at the baseline clothing scenario. Exposures for most scenarios were less than 0.1 mg/kg/day. The only scenario where exposure exceeded the 0.5 mg/kg/day level was for application using a backpack sprayer. Short- and intermediate-term risks were considered to be below the Agency's level of concern for 6 exposure scenarios at the baseline clothing level using all available data, including the chemical-specific data (i.e., no mixer/loader scenarios, mostly direct animal treatments and other agricultural methods at lower rates).

Since unacceptable risks were estimated for some exposure scenarios at the baseline clothing level, risk mitigation was applied in an attempt to reduce risk. When as assessment was completed for individuals wearing additional clothing layers (e.g., coveralls and gloves) and respirators (as appropriate), exposures were reduced for all scenarios. Only the backpack scenario resulted in an estimated exposure of greater than 0.03 mg/kg/day. Short- and intermediate-term exposures and risk were below the Agency's level of concern for the remaining scenarios after the application of appropriate clothing/PPE risk mitigation measures except for the backpack application scenario. Another risk mitigation option for the agency is to require the use of engineering controls such as closed tractor cabs and closed mixing/loading systems. These options are not considered to be viable for decreasing risks to tetrachlorvinphos except for the use of water soluble bags for packaging wettable powders (a mitigation which was not needed, since risk was below the Agency's level of concern). There were no data available to calculate exposure and risk associated with the dust and pellet feed-through scenarios.

Cancer risks were calculated using a Q_1^* value of 1.83×10^{-3} $(mg/kg/day)^{-1}$ by calculating a lifetime average daily dose (LADD) over a 70 year lifetime. Over this lifetime, individuals were expected to have an average working life of 35 years and to handle tetrachlorvinphos from 3 times per year to one time per week over their working lifetime. **Occupational cancer risks of less than 1×10^{-4} were achieved for all scenarios using baseline clothing scenarios (depending on use frequency); however, since risk levels varied based on the number of events per year, risk was unacceptable for some of the higher frequency baseline clothing scenarios. Mitigation through addition of PPE (i.e., additional clothing and gloves) resulted in estimated cancer risks in the 1×10^{-5} range at higher use frequencies, and in the 1×10^{-6} range or lower for the lower use frequencies**.

Four major input parameters are needed to complete handler risk assessments including unit exposure values specific to the application equipment and level of risk mitigation; application rate; amount that can be treated in a day; and the toxicology parameters. Chemical-specific data discussed above were used to address relevant scenarios, and PHED was used to complete the remaining exposure assessments. Unit exposure values obtained from PHED are assigned a "level of confidence" based on the analytical quality of the selected data and the number of available data points (i.e., high, medium, or low confidence), and generally reflect exposure guideline requirements. For example, in a high confidence data set the analytical qualities of the study meet guideline requirements and include an adequate number of data points. One parameter would be circumspect for medium quality data and both parameters would be circumspect for low confidence data.

In the tetrachlorvinphos handler exposure assessment, data for most scenarios where PHED was used are considered to be low to medium confidence. Maximum application rates were generally used; this is considered to be a conservative assumption, since maximum rates are not commonly used. No chemical-specific use data were available to develop a typical application rate for the cancer component of the risk assessment. Therefore, the maximum application rates for all scenarios were used to complete the cancer assessment. Amortization parameters used to

calculate the LADD values (35 working years and up to weekly use over that interval) are likely to over-estimate exposure in the cancer assessment. The estimate of daily treated acres or animals per day is considered to be a reliable estimate of what can be done on a single, very productive day; the daily treated values used in determining tetrachlorvinphos exposures are standard inputs routinely used by the Agency. These estimates are likely to be conservative in estimating cancer risk. A chemical-specific dermal absorption factor (relative to oral dosing) of 9.57 percent was selected by the HIARC and used in all tetrachlorvinphos exposure and risk assessments.

Based on these considerations, the short- and intermediate-term handler exposure and risk assessments are characterized as upper-bound estimates; HED has relatively low confidence in these estimates, due to the quality of the PHED data used. However, for most scenarios, the MOEs that were calculated were considered to be protective, sometimes by large percentages or orders of magnitude. Therefore, the quality of the exposure data may not be as critical in the evaluation of this assessment. **The cancer assessment should be considered conservative because of the LADD amortization factors and due to the fact that maximum application rates were used for all assessments**.

Post-application Exposure/Risk

Tetrachlorvinphos uses supported through reregistration are not expected to result in significant occupational post-application exposures.

Residential/General Population Exposures and Risk

Handler Exposure/Risk

Handler assessments were completed for individuals applying ready-to-use liquid spray solutions (pressurized aerosols and pump sprays), when dipping or dusting dogs, and when placing a flea collar on an animal.

Handler exposure/risk assessments in the occupational setting often indicate a need for risk mitigation. In the residential setting, however, risk mitigation is not considered to be a viable option in the same manner that it is used in the occupational setting (e.g., extra clothing and a respirator would never be viable on a modern homeowner label because of a lack of training and the ability to enforce such requirements). The only viable risk mitigation options are those inherent in the packaging and formulation such as single use or closed system/coupling products. Unfortunately, exposure data currently used in HEDs assessments do not allow for evaluation of the manner in which subtle product and packaging refinements affect exposure. Therefore, a single clothing scenario was used to calculate exposures for residential handlers (i.e., short pants and short-sleeved shirts, which is thought to be representative of homeowner handlers).

No chemical-specific handler exposure data appropriate for assessing residential handler exposures were submitted in support of reregistration of tetrachlorvinphos. Data from the

Pesticide Handlers Exposure Database (PHED V1.1) were used as described above for occupational handlers, or approaches detailed in the *Standard Operating Procedures for Residential Exposure Assessment* were used to complete the exposure assessment for residential handlers.

The models described in the *Standard Operating Procedures for Residential Exposure Assessment* were used to calculate residential handler exposures for dusting or dipping a dog, using a pump sprayer, and for placing a flea collar on an animal. Thirteen residential handler scenarios were identified for tetrachlorvinphos. Estimated exposures (absorbed dose value presented) for all scenarios were less than 0.5 mg/kg/day with a maximum level of 0.46 mg/kg/day calculated for dusting a large animal (i.e., using a whole dust can). The lowest exposure was 4.4×10^{-5} mg/kg/day and most exposure levels were in the 0.1 mg/kg/day range. Short-term residential handler risk was below the Agency's level of concern for 5 of the 13 exposure scenarios including dipping small dogs, using flea collars, and using a pressurized aerosol spray.

Residential cancer risks were calculated using a Q_1^* value of 1.83×10^{-3} $(mg/kg/day)^{-1}$ coupled with a lifetime average daily dose (LADD) over a 70 year lifetime. Over this lifetime, individuals were expected to own pets for either 20 or 40 years of their lives and to treat their pets (or pet living areas) monthly to weekly; use of 2 pet collars per year was assumed). **Residential cancer risks of less than 1×10^{-7} were estimated for all collar and pressurized aerosol spray can scenarios. Cancer risks were in the 10^{-7} to 10^{-6} range for all other scenarios (e.g., dusting, dipping, pump sprayer) and risks for these scenarios exceeded 1×10^{-6} in some cases. Estimated cancer risks for all but the dust use scenario were less than 1×10^{-5}; in the dust scenario, use of one can/month for 40 years was assumed**.

Four major input parameters are needed to complete handler risk assessments, including unit exposure values specific to the application equipment and level of risk mitigation; application rate; amount that can be treated in a day; and the toxicology parameters. No chemical-specific exposure data appropriate for use in residential handler assessments were submitted in support of reregistration of tetrachlorvinphos. Therefore, either PHED or models described in the SOPs for Residential Exposure Assessment were used to estimate exposure and risk.

The PHED data used were the best available but are still only considered to be medium confidence data due analytical quality and the number of data points. Maximum application rates were assumed in assessing short-term risk; this approach is considered to be conservative, since maximum application rates are not commonly used. No chemical-specific use data were available to develop a typical application rate for the cancer component of the risk assessment. Therefore, maximum application rates for all scenarios were used to complete the cancer assessment. The amortization parameters used to calculate the LADD values (20 or 40 years of pet ownership and treatment and up to weekly use over that interval) are considered to be conservative for estimating cancer risk. This characterization is supported by data from the National Home and Garden Pesticide Use Survey completed by the agency in 1992.

The daily treated parameters, such as the amount used per day, or the use of an entire can of product, are considered to be reliable upper-bound estimates of daily usage, and are routinely used by the Agency in residential exposure assessments. These assumptions are likely to result in conservative estimates of cancer risk. A chemical-specific dermal absorption factor (relative to oral consumption) of 9.57 percent was selected by the HIARC and used in all assessments.

Based on these considerations, the short-term residential handler assessments for tetrachlorvinphos are characterized as upper-bound estimates of exposure, and are considered to be reliable due to the quality of the PHED data used and the general conservative nature of the SOPs for Residential Exposure Assessment. It should also be noted that for most scenarios, the MOEs that were considered to be protective, sometimes by large percentages and even orders of magnitude. Therefore, the quality of the exposure data may not be as critical in the evaluation of this assessment. **The cancer assessment should be considered conservative because of the LADD amortization factors and due to the fact that maximum application rates were used for all assessments**.

Post-application Exposure/Risk

Tetrachlorvinphos is used only for direct animal and animal premise treatment in a residential environment. Some significant residential exposure scenarios that have been identified include contact with previously treated pets that translates to considering adult dermal contacts, toddler dermal contacts, and toddler exposures from hand-to-mouth activity following contact with treated pets. In addition, cancer risks were calculated for adults following dermal contact with treated pets.

No chemical-specific data are available to support pet treatments. Therefore, the SOPs for Residential Exposure Assessment were used to address this scenario. In the SOPs, no dissipation is thought to occur; however, for the purposes of this assessment, a minimal dissipation rate of 1 percent per day was used and an average dose representing the interval between applications was used for the cancer LADD calculations.

The dose attributable to dermal contact with treated pets on the day of application for adults ranges from 0.015 to 0.093 mg/kg/day and for toddlers ranges from 0.069 to 0.43 mg/kg/day. The dose for toddlers attributable to hand-to-mouth activity during contact with treated pets ranges from 1.3 to 8.3 mg/kg/day. In the residential setting, risk mitigation is not considered to be a viable option in the same manner that it is used in the occupational setting (e.g., restricted entry intervals). The only regulatory actions available are the development of more refined data or modification of the use pattern (e.g., alter application rates, remove certain uses, etc.).

Short-term risks were below the Agency's level of concern in only one exposure scenario for adults (i.e., animal dipping). All toddler MOEs were less than 65 (acceptable = 100) for the dermal scenario and less than 5 when hand-to-mouth activity was considered. Time weighted average values were used to calculate adult cancer risks resulting from dermal contact

with a treated animal. These residential cancer risks were calculated using a Q_1* value of 1.83 x 10^{-3} $(mg/kg/day)^{-1}$ by calculating a lifetime average daily dose (LADD) over a 70 year lifetime. Over this lifetime, individuals were expected to own pets for either 20 or 40 years of their lives and to treat their pets (or pet living areas) 5 to 12 times per year. **Risks from treatments with aerosol cans were less than 1 x 10^{-8}. Cancer risks were in the 10^{-7} to 10^{-6} range for most other scenarios with risks for many of these scenarios exceeding 1 x 10^{-6}. Estimated risks for all of these scenarios, except three, were less than 1 x 10^{-5} (i.e., dog dip and dust uses)**.

The post-application dose levels calculated for adults and toddlers based on dermal contact and on hand-to-mouth activity for toddlers are considered to be conservative because the dose levels calculated for a single exposure pathway are generally orders of magnitude greater than those indicated by available population-based biological monitoring data. Maximum application rates were assumed, and little or no dissipation was considered. Furthermore, the models use overly conservative estimates for residue transfer and ingestion (e.g., 100 percent of material on the hand is transferred) in each hand-to-mouth event.

Maximum application rates for all scenarios were also used in assessing cancer risk, and the amortization parameters used to calculate the LADD values (20 or 40 years of pet ownership and treatment and up to weekly use over that interval) were conservative in nature. This characterization is supported by data from the National Home and Garden Pesticide Use Survey completed by the agency in 1992.